Get Wet 2016

Flow Visualization

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For the first project of the semester, Get Wet 2016 is a project to start to experiment with capturing the physics behind fluid flows. Sublimation of CO_2 in warm water is a fluid flow that has been seen by most, usually around Halloween, was a phenomenon that has always caught my interest. Solids sometimes can skip the liquid phase and change from solid form directly to a gas, this is known as sublimation. Carbon dioxide (CO_2) has an extremely low boiling point at atmospheric pressure, making it a great candidate to observe this phenomenon. When solid carbon dioxide is exposed to the earths atmospheric environment, sublimation occurs without the need for anything other than heat. Solid CO_2 sublimates at roughly -110° F and by adding some warm water to the process we are able to further visualize the flows.

To complete the experiment, a small bowl was used to contain the solid CO_2 as displayed in Figure 1 below.

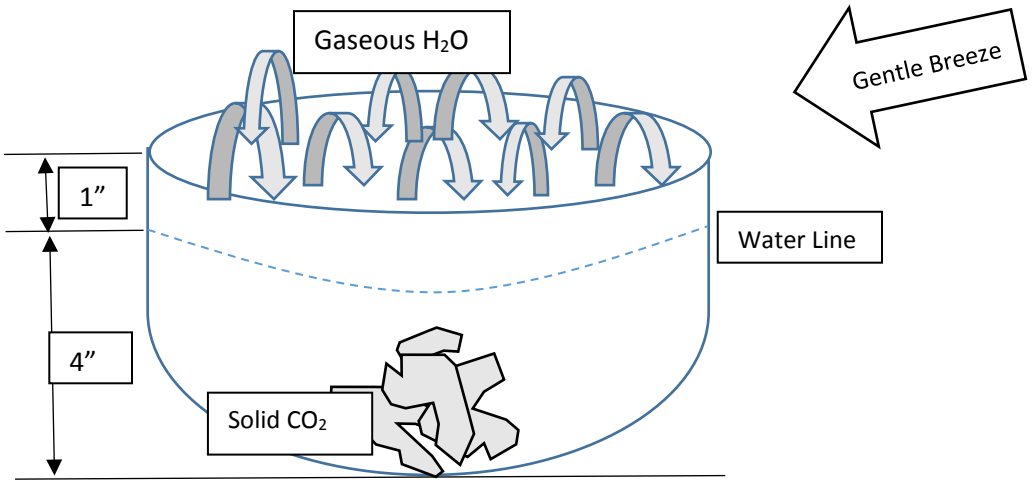

Figure 1: Experiment set-up side view

Chemically something interesting happens when the solid CO_2 is placed into liquid water, because of the extreme cold that is produced during the sublimation.

$$CO_2(s) \text{ ----> } CO_2(g) \text{ while, } H_2O(l) \text{ ----> } H_2O(g) \text{ ----> } H_2O(l)$$

As the gaseous CO_2 bubbles rise, water condenses in the bubble as water fog. The Gentle Breeze was not used to induce any fluid flows. The light breeze was moments before the photo was taken, simply to expose the bubbles below the surface of the water. The image was taken shortly after the addition of the warm water to the bowl. If too much time passed before the photograph was taken, the sublimation slows to a rate unappealing to the eye.

As seen in Figure 2 below, there was the addition of a light source to the right side of the camera position. As the gasses rise up out of the bowl, they begin to expand quickly creating blurry outlines of the clouds. A very bright white light flashlight bar was utilized to create enough light to employ a very short shutter speed, stopping the motion of the fluids and giving the desired shadows.

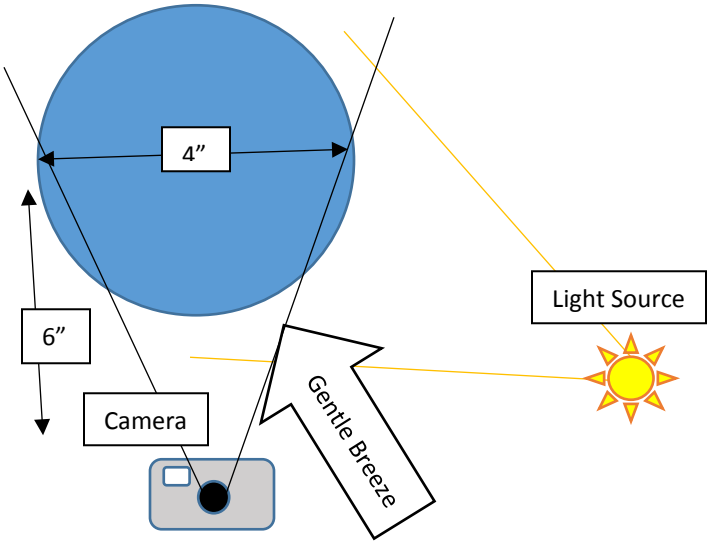

Figure 2: Experiment set-up top view

As displayed above in Figure 2, Using a Panasonic DMC-ZS50, a compact digital camera, the Image is roughly four inches across with only about six inches between the focus point and the lens. The exposure specs are as follows; focal length of 4 mm, ISO of 80, F-stop of f/8, and exposure time of 1/25 sec. Very few manipulations were applied to the photograph after it was taken. The image was cropped, turned to black and white and contrast adjusted to create the final image.

Figure 3: Original Photograph (left), Final Image (right)

Viewing the creation of a temporary cloud inside the safety of one’s own is fascinating. Creating enough light in the correct location to get an optimal photograph is difficult. Overall I am happy with the final product, with the physics of sublimation of solid CO_2 are displayed in an artistic manner. There are a few improvements that I would make if I were to recreate this image. Creating a brighter image before adding after effects and thinking about the color of the bowl could create a more professional image displaying the same physics. Going further into this topic, generating the same images of sublimation under different atmospheric constraints would be interesting to say the least.